

Vector Control in the United States

A VECTOR, according to Webster's unabridged dictionary, is "an organism, usually an insect, which carries and transmits disease-causing micro-organisms." This is the classic definition of a vector. Since living languages are constantly changing in vocabulary and in word definitions, it is probably only a matter of time before dictionaries will begin to include broader and supplementary usages of the term "vector," consistent with current usage of the word. It is our purpose to define what "vector control" means today and to review the justification for modern vector control as carried on in this country.

Less than 30 years ago, as many as a million cases of malaria annually were estimated to have occurred in the United States, principally in the southern States. As many as a hundred thousand cases annually were attributed to each of several States. While malaria was undoubt-

edly the leading vectorborne disease, the aggregate incidence of other vectorborne diseases was very high by present-day standards, especially that portion of the dysenteries and diarrheas which is transmitted by houseflies to infants. At the same time, personal services and physical resources available to combat these diseases were negligible in relation to their extent and magnitude.

As recently as 1929 in one State with 100,000 cases of malaria, only one engineer was actively engaged in malaria control, giving part-time service to State and local health departments. It was not only natural but indeed essential under this setting for vector control to be conducted as a highly species-selective sanitation operation, at least in its malaria control aspect.

Such conditions still prevail in many parts of the world. Even though no method of control is completely species selective, focalization of effort against the production and resting places of the vector species, especially of the infected individual specimens, permits this objective to be substantially realized. Moreover, even in the United States, species-selective sanitation is still applicable today for the control and eradication of the yellow fever and dengue vector, *Aedes aegypti*.

All methods of vector control fall within the classic definition of sanitation. Irrespective of whether it is achieved by chemical, physical, biological, or other means, vector control involves the modification of man's environment in the interest of human health and well-being. However, because of the foregoing historic precedents, vector control in the professional and administrative mind has assumed a more selective position than other sanitation methods. Aside from certain special types of public water supply problems employing chlorination as a sole method of treatment, all other commonly employed sanitation measures have broader

The Committee on Vector Control, Engineering and Sanitation Section, American Public Health Association, presents this fifth annual report in full awareness that imposed limitations on length have prevented giving adequate attention to all aspects of the scope of vector control. Hence, attention has been concentrated largely on the scope and program complexities of mosquito control to the neglect not only of many other important vector species but also of source control aspects, especially in mosquito and fly control. Coverage of these aspects in turn would have more adequately exposed to fuller view the scope of vector control programs from a standpoint of agricultural, industrial, and community relationships. Members of the 1956 committee were John M. Henderson, C.E., chairman, George Bradley, Ph.D., Francis E. Gartrell, D.P.H., Wesley E. Gilbertson, M.S.P.H., Harold Gray, M.S., Ralph S. Howard, Jr., M.S., John A. Mulrennan, B.S.A., Theodore A. Olson, M.A., Richard F. Peters, B.S., and Fred H. Stutz.

purposes and benefits than the direct interruption of disease transmission. By the same token, sanitation in general prevents as well as controls disease incidence. In contrast with this philosophy of multipurpose benefit, vector control concepts have followed more closely the philosophy of the case-finding epidemiologist who pinpoints his efforts on the investigation and control of individual disease outbreaks during or following their occurrence.

Evolving Concept of Vector Problems

The attitude of the public toward vector control, however, almost invariably has been in accord with professional concepts of general sanitation. Sewage nuisances are not to be tolerated, not alone because of specific disease potentialities, but because they are obnoxious to the general enjoyment of life. Water should be treated not alone to remove infectious microorganisms, but to make it socially and economically usable and acceptable in other respects. All insects which bite man in numbers are undesirable and should be done away with at public expense when they constitute a public nuisance.

Illustrative of this prevailing attitude, even in certain underdeveloped areas where malaria is a primary socioeconomic problem, was the great early popularity of DDT residual spraying—not primarily because the spraying controlled malaria or reduced enteric diseases, but because houseflies no longer bothered people. Conversely, the subsequent development of resistance by houseflies to DDT has hampered the execution of malaria control programs in some of these areas.

In recent years, thinking in professional public health circles has begun to come abreast of the lay attitude toward sanitation. Explicit in the Constitution of the World Health Organization is the statement:

“Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.”

In harmony with this “positive health” concept and directly applicable to vector control is the following policy statement of the Acting Surgeon General of the Public Health Service in 1950 (1):

“It is our conviction that pest mosquitoes should receive more attention from health authorities than they have in the past. Public health has become something more than the absence of disease. Physical efficiency and comfort, on which mental equanimity depends to a substantial degree, may be seriously disturbed by the continued annoyance of pestiferous mosquitoes which may or may not have disease transmitting potentialities.”

The Tennessee Valley Authority, long noted for its comprehensive and effective programs for control of the malaria vector, *Anopheles quadrimaculatus*, on its impoundages, has recognized the importance of controlling other species as well. In the spring of 1956, TVA's policy was amended to include control “of these other mosquitoes when their production in TVA waters constitutes a nuisance to sizable population groups or hazard to the public health.”

Of current interest also is the frank recognition by the Public Health Service, its parent department, and the Congress that, in effect, not only is air pollution more than a communicable disease problem or even a respiratory illness problem, but a detriment to positive health and to general socioeconomic well-being. Accordingly, the Air Pollution Control Act (P. L. 159, 84th Cong.), which is administered by the Public Health Service under the supervision and direction of the Secretary of Health, Education, and Welfare, does not restrict the program of research and technical assistance to classic disease control aspects, but rather to this public problem as an entity.

As stated by Dr. Justin M. Andrews of the Public Health Service (2): “This is a very broad act which recognizes that air pollution may endanger health and welfare, injure agricultural crops and livestock, damage property, and create hazards to air and ground transportation. Thus, it is not limited to health in its implementing provisions.” There is evidence of a similar breadth of approach to the air pollution problem on the part of affected State and local health departments, consistent with the sanitation tradition.

The air pollution problem in many respects is considered analogous to certain current vector problems in the United States. The severe

invasion of the city of St. Petersburg, Fla., and adjacent recreational areas by salt marsh mosquitoes in 1956, for example, may be compared with a severe smog episode in the city of Los Angeles. Smog episodes in Los Angeles are usually accompanied by numerous cases of eye irritation and discomfort. In St. Petersburg, there were reports of many cases of severe dermatitis requiring medical attention, especially among young children and infants.

In both cities specific disease transmission attributable to the respective environmental episodes was apparently absent. But the dislocation of community functions was pronounced, and there were clear-cut adverse effects on positive health, recreational activities, and mental equanimity. An aggravation of certain morbid conditions can be attributed in varying degrees to the episodes.

Vector problems in this country today may be broadly classified into three principal categories: (a) classic vectors which are responsible for the transmission of infectious disease at the present time, (b) species which possess public health and general socioeconomic importance as public nuisance problems, and (c) classic vectors which were responsible for the transmission of infectious disease in the past, but not at present. This classification is not clear cut since classic vectors in both categories may be public nuisance problems as well, depending on time and place. Conversely, nearly all the important species of mosquitoes which are commonly considered in this country as being primarily nuisance problems have either been incriminated in disease transmission at some time or place or have been proved experimentally to be capable of transmitting disease.

The chief vectors in the United States in the first category today are the housefly in areas where there is still a significant incidence of flyborne enteric infections, and those mosquito species which in various parts of the country are principal vectors of the encephalitides. Chief among these is the mosquito species *Culex tarsalis* widely distributed in the western irrigated States, especially in California. *Culex quinquefasciatus*, predominantly a nuisance species in most parts of the United States, is also a major vector of encephalitis in Texas.

The nuisance category comprises a large number of species which, individually or in small groups, present major problems in individual localities or larger areas. It is this group which today constitutes the basis for the enlarged definition of the term "vector." The group encompasses those insects and other animals which may adversely affect to an important degree the health objectives which are explicit or implicit in the WHO's and the Surgeon General's pronouncements. The importance of these problems has been adequately described and emphasized by the resolutions which were passed in 1955 and 1956 by the Association of State and Territorial Health Officers, the American Public Health Association, and several other more specialized bodies.

We prefer to see the justification for the control of such species presented on the clear-cut issue of their actual, well-established interference with man's interests. Irrespective of whether they do or do not constitute public health problems from everyone's point of view, we maintain that the control of these mosquitoes at public expense whenever they become primary public nuisances is warranted and indeed, often essential, to community existence. We further consider that local health and health-related agencies are the logical instrumentalities for carrying on such control measures. But to do so some of the agencies must manifest a greater interest in the needs and desires of the community pertaining to insect control as well as furnish the leadership and the guidance that the community needs and has a right to expect.

Uninterrupted technical service and research by State and Federal health agencies and other organizations is sorely needed to complement local action programs. We believe it to be more in the public interest to spend money for the control of such species than for the routine control of classic vectors which in the historic past have been responsible for disease in this country but no longer are, unless these historic vectors now constitute a significant nuisance problem. Apropos of this position, we quote another statement by Dr. Andrews, this time in reference to the mosquitoes of the far north (3).

"But whether these creatures spread disease

from lower animals to man, or from man to man, or whether they have nothing whatever to do with spreading disease, their overpowering numbers and vicious biting habits make insect control an almost necessary prelude to land development. To imply that they are unimportant from a health standpoint simply because they are not known to transmit infectious organisms is to discredit the basic tenet of the World Health Organization Charter. Thus, insect control becomes an essential function of health organizations in bringing about relief from severe insect pestiferousness."

However, for those whose interest in mosquitoes is limited to the classic approach, we call attention to the fact that knowledge of the etiology and public health significance of mosquito-borne viruses is in an embryonic and dynamic stage. Indicative of this is the recent isolation of 31 different unknown mosquito-borne viruses in a single year by a single laboratory in South America. These viruses were obtained from seven different genera of mosquitoes (4). We note further that many of the more important species of so-called nuisance mosquitoes in this country have been found naturally infected with one or more strains of encephalitis virus.

Practical Aspects of Vector Control

From the standpoint of a control program, the intimate interrelationship between vectors and nuisance species in this country today is often imperfectly understood. A prime example is provided by *Aedes nigromaculis* and *C. tarsalis* in California. *A. nigromaculis* is the principal nuisance species. *C. tarsalis* is the principal vector of encephalitis and a secondary nuisance problem. Neither species is controllable by DDT residual house spraying. Both species are mainly found in irrigated areas in California. About \$3.4 million are locally appropriated each year in that State for mosquito control work performed by organized mosquito control districts or related organizational groups in local health departments.

Mosquito production through irrigation projects is a manmade problem. The basic method of control, therefore, is prevention and applies in large measure to both vector and

nuisance species. Employment of recommended irrigation practices is in the joint interest of soil and water conservation, higher crop production, and avoidance of mosquito production. Permanent eliminative measures of recurrent control by larviciding tend to control vector and nuisance species, but in varying degree, depending on the amount of selectivity practiced. However, because of various factors, including differences in length of cycle from ovum to imago and preferences in microhabitat by the ovipositing female, it is possible to carry on species control measures which will suppress *C. tarsalis* considerably more effectively than *A. nigromaculis*. Such a program could be conducted at somewhat less expense than the present one.

If, as might be advocated by the public health purist, mosquito control forces were directed toward controlling only the classic vector insofar as possible, the following consequences could logically be expected: (a) abandonment or drastic curtailment of organized local mosquito activities since it is well established that public support for local mosquito control appropriations in California is mainly motivated by the desire for freedom from discomfort; and (b) a tendency to emphasize more highly selective palliative measures at the expense of species-comprehensive preventive measures.

One theoretical alternative would be the establishment of two mosquito control organizations in each local area: one to control classic vectors and one to control other mosquito species. Technical services and financial aid to local areas by the State, similarly, would be furnished by two separate State departments, each functioning in its own compartment.

The impracticality of either plan, we believe, is so obvious that the issue should not be labored further. But we wish to point out that the California program of controlling all mosquito species which constitute a public nuisance not only satisfies the public interest and results in economy in government, but also makes possible the provision of local organizations and funds which otherwise would not be available for controlling the classic vector. Accordingly, classic vector control objectives are directly served by nuisance mosquito control. Conversely, in other situations nuisance control

interests have been and continue to be served by programs for the control of classic vectors.

Curiously, workers in certain quarters either have accepted or are believed to be readily capable of accepting the logic that local health departments should carry on comprehensive mosquito control but that supportive services by State and Federal health departments should be totally or almost entirely restricted to "classic vectors." This is in contrast, for example, with the position of the Florida Legislature which considers that all of the more important nuisance arthropods are of public health concern. This legislature has directly charged the Florida State Board of Health with the administration of a large State subvention appropriation for comprehensive control by local agencies and with a concomitant program of direct research and technical supervision.

Since California has been selected as offering an example of the integral relationship between classic vectors and nuisance species from a control standpoint, State agency supportive service in that State might well be reviewed. Such supportive service includes a modest State subvention appropriation to local mosquito control agencies for the principal purpose of augmenting control of the classic vector. However, because of the interrelationship between the production of the various mosquito species, it is not possible to spend these subvention funds in a manner which insures their exclusive application to *C. tarsalis*. Of more significance from a policy standpoint is the fact that most of the local mosquito control agencies in California look to the State department of public health chiefly for technical information and other service on new or improved methods of controlling problem mosquitoes, irrespective of their particular vectorial status.

Toward the discharge of this function, the health department, through its bureau of vector control, carries on certain investigations of control operations and research activities. The control of *A. nigromaculis* is more difficult than that of *C. tarsalis*, and it is also a problem of even greater magnitude. Hence, it is the position of local agencies and the bureau that enhancement of the adequacy of control of *C.*

tarsalis by local operating agencies can be brought about as expeditiously, and often more readily, by the development of new and improved methods of controlling *A. nigromaculis*, as by similar progress toward the direct control of *C. tarsalis*. Yet such activities by State and Federal agencies are not uncommonly considered inappropriate, at least by the very effective action of opposing appropriations for their prosecution.

As traditionalists in public health administration, the committee members consider that the first responsibility of State and Federal health agencies is to support local health agencies by research in needed fields and in such other manner as may be appropriate. They consider that the scope of such support should be established by the actual programs and needs of local health agencies since these yardsticks provide a more reliable measure of public needs and interests than any other.

Last, we wish to offer the afore-described enigma as further evidence of the error of arbitrarily compartmentalizing the components of any sanitation system into so-called public health and nonpublic health categories or into major and irrelevant categories. We consider it infeasible, for example, in the United States today under prevailing health and socioeconomic conditions to draw a sharp distinction in the sanitation of food-handling establishments between infectious dirt and noninfectious dirt, the proper objective rather being a clean establishment and "sanitation as a way of life." The same principle extends into all fields of sanitation, including air pollution, water quality control, housing, and last, but not least, vector control.

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